

**Patient safety: Evaluation of the impact  
of nursing hours per patient day staffing  
method in Western Australia**

Diane Esma Twigg

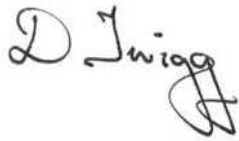
Doctor of Philosophy

2009

## **Certificate of Authorship/Originality**

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

A handwritten signature in black ink, appearing to read "D. J. Wigg". The signature is written in a cursive style with a large, stylized "D" and "W".

## **Acknowledgements**

I wish to express my deep gratitude and sincere thanks to the following people who have given me sound advice, great support and consistent encouragement throughout this doctoral journey. Firstly, my principal supervisor Professor Christine Duffield who demonstrated great skill in keeping me focussed on the task at hand and in teaching me the art of academic writing. Her knowledge and understanding in the areas of leadership, workforce and patient outcomes were the source of many great discussions and were invaluable in assisting me to undertake this study. I would also like to acknowledge and thank my co supervisor, Dr Patricia Rapley. Pat's eye for detail and thoroughness was greatly appreciated. My thanks also go to Cecily Gilbert, the hospital librarian. Her assistance in establishing key literature searches, sourcing articles and proof reading the thesis was greatly appreciated. I would also like to thank The Western Australian Nurses Memorial Charitable Trust for their generous grant which was of enormous benefit to me in conducting this research. It enabled me to employ a research assistant to assist with data cleansing and to seek the advice of a biostatistician. My thanks also go to Norjin Kelsang, my research assistant, for her thorough attention to detail and Dr Alex Bremner for her invaluable statistical advice and supervisory support to the method and results chapters. I would also like to acknowledge Professor Judith Finn for her advice in regard to the SPSS syntax and Judy Ewing for her valuable editing advice. Finally, I would like to thank my good friend and colleague, Sue Davis for her encouragement to undertake this work and her notorious sense of humour and 'one liners' that assisted me in keeping this work in perspective.

# Table of Contents

<b>CERTIFICATE OF AUTHORSHIP/ORIGINALITY .....</b>	<b>I</b>
<b>ACKNOWLEDGEMENTS .....</b>	<b>II</b>
<b>TABLE OF CONTENTS .....</b>	<b>III</b>
<b>LIST OF TABLES.....</b>	<b>VII</b>
<b>LIST OF FIGURES .....</b>	<b>X</b>
<b>ABSTRACT .....</b>	<b>XI</b>
<b>CHAPTER 1: INTRODUCTION .....</b>	<b>1</b>
1.1 HEALTH REFORM AND ITS IMPACT ON NURSING .....	2
1.2 AUSTRALIAN HEALTH-CARE SYSTEM .....	7
1.3 THE AUSTRALIAN INDUSTRIAL RELATIONS SYSTEM.....	8
1.4 THE NURSING WORKFORCE .....	9
1.5 DETERMINING ADEQUATE NURSE STAFFING .....	12
1.6 DETERMINING ADEQUATE NURSE STAFFING IN AUSTRALIA .....	15
1.7. PURPOSE OF THE STUDY .....	16
1.8 RESEARCH QUESTIONS.....	17
1.9 OPERATIONAL DEFINITIONS .....	18
1.9.1 Nursing hours .....	18
1.9.2 Skill mix .....	18
1.9.3 NHPPD ward category.....	18
1.9.4 Nursing-sensitive outcomes (NSOs).....	18
1.9.5 Multi-day wards .....	21
1.9.6 Multi-day patient separation .....	21
1.9.7 Adult tertiary hospital .....	21
1.10 SUMMARY.....	21
1.11 ORGANISATION OF THE THESIS .....	22
<b>CHAPTER 2: A REVIEW OF NURSING WORKLOAD AND STAFFING METHODS.....</b>	<b>23</b>
2.1 NURSING WORKLOAD .....	23
2.2 AN OVERVIEW OF WORKLOAD MEASURES .....	24
2.3 MANDATED NURSE STAFFING .....	31
2.4. NURSING WORKLOAD ISSUES IN AUSTRALIA.....	34

2.5 EVOLUTION OF THE WEST AUSTRALIAN STAFFING METHOD, NURSE HOURS PER PATIENT DAY (NHPPD) .....	36
2.6 SUMMARY .....	43
2.7 CONCLUSION .....	44
<b>CHAPTER 3: PATIENT SAFETY, QUALITY AND A CONCEPTUAL FRAMEWORK TO GUIDE THE STUDY .....</b>	<b>46</b>
3.1 EVOLUTION OF THE PATIENT SAFETY MOVEMENT .....	46
3.2 NURSING'S CONTRIBUTION TO PATIENT SAFETY .....	61
3.3 CONCEPTUAL FRAMEWORK .....	64
3.4 SUMMARY .....	68
<b>CHAPTER 4: THE RELATIONSHIPS BETWEEN NURSING AND PATIENT OUTCOMES .....</b>	<b>70</b>
4.1 THE IMPACT OF NURSE-TO-PATIENT RATIOS/NURSE HOURS PER PATIENT DAY ON NURSING-SENSITIVE OUTCOMES .....	70
4.2 THE IMPACT OF SKILL MIX ON NURSING-SENSITIVE OUTCOMES .....	76
4.3 THE COSTS OF INCREASING REGISTERED NURSE STAFFING .....	82
4.4 THE NURSING WORK ENVIRONMENT .....	85
4.5 NURSING OUTCOMES .....	90
4.6 SUMMARY .....	92
<b>CHAPTER 5: METHOD .....</b>	<b>96</b>
5.1 PURPOSE .....	96
5.2 RESEARCH QUESTIONS .....	96
5.3 STUDY DESIGN .....	97
5.4 DATA SOURCES AND COLLECTION .....	98
5.4.1 Data inclusion criteria .....	99
5.4.2 Data exclusion criteria .....	99
5.5 SAMPLE .....	100
5.6 DATA ANALYSIS .....	101
5.6.1 Descriptive statistics .....	101
5.6.2 Preparation for inferential analysis .....	101
5.6.3 Inferential statistics used to answer the research questions .....	104
5.7 ETHICAL CONSIDERATIONS .....	106
5.8 SUMMARY .....	106
<b>CHAPTER 6: RESULTS .....</b>	<b>108</b>
6.1 DATA CLEANSING RESULTS .....	109
6.1.1 Data cleansing of patient data .....	109

6.1.2 Data cleansing of staffing data.....	111
6.1.3 Creation of Data Analysis files.....	115
6.2 PATIENT AND NURSE STAFFING DEMOGRAPHIC DATA.....	115
6.2.1 Patient demographic data .....	115
6.2.2 Staffing demographics, nursing hours and skill mix.....	117
6.3 TRENDS IN NURSING-SENSITIVE PATIENT OUTCOME RATES OVER THE FOUR YEAR PERIOD OF THE STUDY .....	123
6.4 THE IMPACT OF IMPLEMENTATION OF THE (NHPPD) STAFFING METHOD ON NURSING-SENSITIVE OUTCOMES IN THREE ADULT TERTIARY HOSPITALS (WARD CATEGORIES A, B, C AND D COMBINED) AND INDIVIDUAL WARD CATEGORIES A, B, C AND D AT ONE ADULT TERTIARY HOSPITAL .....	125
6.4.1. <i>The impact of implementation of the (NHPPD) staffing method on nursing-sensitive outcomes in three adult tertiary hospitals (ward categories A, B, C and D combined).....</i>	127
6.4.2 <i>The impact of implementation of the (NHPPD) staffing method on nursing-sensitive outcomes in individual ward categories A, B, C and D at one adult tertiary hospital.....</i>	140
6.5 THE IMPACT OF SKILL MIX ON NURSING-SENSITIVE OUTCOMES FOLLOWING IMPLEMENTATION OF NHPPD IN THREE ADULT TERTIARY HOSPITALS (WARD CATEGORIES A, B, C AND D COMBINED) AND IN INDIVIDUAL WARD CATEGORIES A, B, C AND D AT ONE ADULT TERTIARY HOSPITAL .....	151
6.5.1 <i>The impact of skill mix on nursing-sensitive outcomes following implementation of NHPPD in three adult tertiary hospitals (ward categories A, B, C and D combined).....</i>	151
6.5.2 <i>The impact of skill mix on nursing-sensitive outcomes following implementation of NHPPD in individual ward categories A, B, C and D at one adult tertiary hospital .....</i>	163
6.6 SUMMARY.....	174
<b>CHAPTER 7: DISCUSSION .....</b>	<b>176</b>
7.1 IMPACT OF THE NURSE HOURS PER PATIENT DAY (NHPPD) STAFFING METHOD ON NURSING-SENSITIVE OUTCOMES .....	178
7.2 THE IMPORTANCE OF SKILL MIX IN ACHIEVING IMPROVED PATIENT OUTCOMES.....	184
7.3 SUMMARY OF FINDINGS.....	190
7.4 IMPLICATIONS FOR NURSE LEADERS AND NURSE EXECUTIVES .....	192
7.5 IMPLICATIONS AND RECOMMENDATIONS FOR POLICY .....	196
7.6 RECOMMENDATIONS FOR FUTURE RESEARCH.....	197
7.7 LIMITATIONS AND METHODOLOGICAL ISSUES .....	197
7.8 CONCLUSION .....	199
<b>APPENDIX A: NURSING-SENSITIVE PATIENT OUTCOME ALGORITHMS .....</b>	<b>201</b>
<b>APPENDIX B: DATA VARIABLES ACROSS HOSPITALS .....</b>	<b>210</b>
<b>APPENDIX C: INDIVIDUAL VARIABLE CLEANSING AND PROCESSING STEPS .....</b>	<b>213</b>

APPENDIX D: EXAMPLE SYNTAX CNS COMPLICATIONS .....	220
APPENDIX E: HOSPITAL 1 EVENT DATA.....	221
APPENDIX F: HOSPITAL NURSING STAFF COST CENTRE INCLUSIONS AND EXCLUSIONS FROM THE STUDY .....	222
APPENDIX G: HUMAN RESOURCE DATA WAREHOUSE (HRDW) DATA VARIABLES AND DEFINITIONS.....	235
APPENDIX H: ENROLLED NURSE/REGISTERED, AGENCY/NON AGENCY NURSE VARIABLE SYNTAX .....	238
APPENDIX I: PART-1 DATA VARIABLES TIME SERIES FILE .....	239
APPENDIX J: PART-2 DATA VARIABLES TIME SERIES FILE .....	241
APPENDIX K: NURSING-SENSITIVE OUTCOMES TRENDS OVER TIME .....	243
APPENDIX L: EVIDENCE OF AR1 FROM AUTO CORRELATION FUNCTION .....	251
APPENDIX M: EVIDENCE OF AR1 FROM AUTO CORRELATION FUNCTION.....	253
BIBLIOGRAPHY .....	255

## List of Tables

<b>TABLE 1.1.</b> <i>NURSING-SENSITIVE PATIENT OUTCOMES INCLUDED IN THE STUDY</i> .....	20
<b>TABLE 2.1.</b> <i>NHPPD GUIDING PRINCIPLES (INCORPORATING MENTAL HEALTH INPATIENT UNITS)</i> .....	40
<b>TABLE 3.1.</b> <i>DATA ON ADVERSE EVENTS IN HEALTH CARE FROM SEVERAL COUNTRIES</i> .....	52
<b>TABLE 6.1.</b> <i>NURSE HOURS PER PATIENT DAY WARD CATEGORIES</i> .....	113
<b>TABLE 6.2.</b> <i>DATA RECORDS</i> .....	114
<b>TABLE 6.3.</b> <i>NUMBER OF PATIENT RECORDS FOR THE THREE ADULT TERTIARY HOSPITALS IN EACH STAGE IN THE STUDY</i> .....	115
<b>TABLE 6.4.</b> <i>DESCRIPTIVE STATISTICS FOR PATIENT DEMOGRAPHIC VARIABLES GENDER, MEAN AGE AND ADMISSION TYPE</i> .....	116
<b>TABLE 6.5.</b> <i>COMPARISON OF PATIENT DEMOGRAPHIC VARIABLES BETWEEN STAGE-0 AND STAGE-2</i> .....	117
<b>TABLE 6.6.</b> <i>FREQUENCY OF NURSING HOURS AND PERCENTAGE (%) OF REGISTERED NURSE SKILL MIX BY FINANCIAL YEAR</i> .....	118
<b>TABLE 6.7.</b> <i>GENERALISED LINEAR EQUATION ANALYSIS OF EFFECT OF STAGE ON HOURS FOR HOSPITALS COMBINED, HOSPITAL 1, 2 AND 3</i> .....	120
<b>TABLE 6.8.</b> <i>GENERALISED LINEAR EQUATION ANALYSIS OF EFFECT OF STAGE ON NURSING HOURS FOR WARD CATEGORIES IN ONE ADULT TERTIARY HOSPITAL</i> .....	120
<b>TABLE 6.9.</b> <i>GENERALISED LINEAR EQUATION ANALYSIS OF EFFECT OF STAGE ON SKILL MIX PERCENTAGE FOR HOSPITALS COMBINED, HOSPITAL 1, 2 AND 3</i> .....	121
<b>TABLE 6.10.</b> <i>MEAN SKILL MIX PERCENT IN STAGE-0 &amp; 2</i> .....	121
<b>TABLE 6.11.</b> <i>EFFECT OF STAGE ON SKILL MIX PERCENTAGE FOR WARD CATEGORIES</i> .....	123
<b>TABLE 6.12.</b> <i>MEAN SKILL MIX FOR WARD CATEGORIES IN STAGE-2</i> .....	123
<b>TABLE 6.13.</b> <i>EFFECT OF STAGE-2 ON NURSING-SENSITIVE OUTCOMES FOR HOSPITALS COMBINED, ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	129
<b>TABLE 6.14.</b> <i>EFFECT OF STAGE-2 ON NURSING-SENSITIVE OUTCOMES FOR HOSPITAL 1 ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	131
<b>TABLE 6.15.</b> <i>EFFECT OF STAGE-2 ON NURSING-SENSITIVE OUTCOMES FOR HOSPITAL 2 ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	133
<b>TABLE 6.16.</b> <i>EFFECT OF STAGE-2 ON NURSING-SENSITIVE OUTCOMES FOR HOSPITAL 3 ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	135
<b>TABLE 6.17.</b> <i>EFFECT OF STAGE SUMMARISED BY NURSING-SENSITIVE OUTCOME, INCIDENCE RATE RATIO (95% CI) AND AVERAGE LENGTH OF STAY (†B) DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	138



<b>TABLE 6.18.</b> <i>EFFECT OF STAGE ON NURSING-SENSITIVE OUTCOMES FOR HOSPITAL 1 CATEGORY A WARDS ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	141
<b>TABLE 6.19.</b> <i>EFFECT OF STAGE ON NURSING-SENSITIVE OUTCOMES FOR HOSPITAL 1 CATEGORY B WARDS ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	143
<b>TABLE 6.20.</b> <i>EFFECT OF STAGE ON NURSING-SENSITIVE OUTCOMES FOR HOSPITAL 1 CATEGORY C WARDS ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	145
<b>TABLE 6.21.</b> <i>EFFECT OF STAGE ON NURSING-SENSITIVE OUTCOMES FOR HOSPITAL 1 CATEGORY D WARDS ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	147
<b>TABLE 6.22.</b> <i>EFFECT OF STAGE SUMMARISED BY NURSING-SENSITIVE OUTCOME, INCIDENCE RATE RATIO (95% CI) AND AVERAGE LENGTH OF STAY (†B) DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	149
<b>TABLE 6.23.</b> <i>EFFECT OF SKILL MIX PERCENTAGE ON NURSING-SENSITIVE OUTCOMES IN STAGE-2 FOR COMBINED HOSPITALS ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	152
<b>TABLE 6.24.</b> <i>EFFECT OF SKILL MIX PERCENTAGE ON NURSING-SENSITIVE OUTCOMES IN STAGE-2 FOR HOSPITAL 1 ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	154
<b>TABLE 6.25.</b> <i>EFFECT OF SKILL MIX PERCENTAGE ON NURSING-SENSITIVE OUTCOMES IN STAGE-2 FOR HOSPITAL 3 ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	156
<b>TABLE 6.26.</b> <i>EFFECT OF SKILL MIX PERCENTAGE ON NURSING-SENSITIVE OUTCOMES IN STAGE-2 FOR HOSPITAL 3 ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	158
<b>TABLE 6.27.</b> <i>EFFECT OF SKILL MIX ON HOSPITALS IN STAGE-2 BY NURSING-SENSITIVE OUTCOME, INCIDENCE-RATE RATIO (95% CI) AND AVERAGE LENGTH OF STAY (†B) DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	161
<b>TABLE 6.28.</b> <i>EFFECT OF SKILL MIX PERCENTAGE ON NURSING-SENSITIVE OUTCOMES IN STAGE-2 FOR HOSPITAL 1 WARD CATEGORY A ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	164

<b>TABLE 6.29.</b> <i>EFFECT OF SKILL MIX PERCENTAGE ON NURSING-SENSITIVE OUTCOMES IN STAGE-2 FOR HOSPITAL 1 WARD CATEGORY B ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	166
<b>TABLE 6.30.</b> <i>EFFECT OF SKILL MIX PERCENTAGE ON NURSING-SENSITIVE OUTCOMES IN STAGE-2 FOR HOSPITAL 1 WARD CATEGORY C ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	168
<b>TABLE 6.31.</b> <i>EFFECT OF SKILL MIX PERCENTAGE ON NURSING-SENSITIVE OUTCOMES IN STAGE-2 FOR HOSPITAL 1 WARD CATEGORY D ALL, MEDICAL AND SURGICAL PATIENTS DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	170
<b>TABLE 6.32.</b> <i>EFFECT OF SKILL MIX ON WARD CATEGORIES IN STAGE-2 SUMMARISED BY NURSING-SENSITIVE OUTCOME, RATE RATIO (95% CI) AND AVERAGE LENGTH OF STAY (†B) DETERMINED BY POISSON (EXP (B)) OR LINEAR REGRESSION (B)</i> .....	173

## List of Figures

<b>FIGURE 3.1.</b> MCCLOSKEY CONCEPTUAL FRAMEWORK ADAPTED FROM AIKEN .....	65
<b>FIGURE 3.2.</b> THE CONCEPTUAL FRAMEWORK USED IN THE PRESENT STUDY (MCCLOSKEY ADAPTED FROM AIKEN MODIFIED) .....	68
<b>FIGURE 6.1.</b> TOTAL NURSING HOURS (ALL PATIENTS) ACROSS HOSPITALS .....	119
<b>FIGURE 6.2.</b> TOTAL RN HOURS (ALL PATIENTS) ACROSS HOSPITALS .....	119
<b>FIGURE 6.3.</b> SKILL MIX PERCENT (ALL PATIENTS) ACROSS HOSPITALS .....	122

## **Abstract**

In March 2002 Western Australia (WA) mandated a new staffing method—nursing hours per patient day (NHPPD). This method used a “bottom up” approach to classify each hospital ward into one of seven categories using characteristics such as patient complexity, intervention levels, the presence of high dependency beds, the emergency/elective patient mix and patient turnover. Once classified, NHPPD were prescribed for each ward. The purpose of this study was two-fold focusing on data from three adult tertiary hospitals (four of seven ward categories: A, B, C and D combined), and individual ward categories A, B, C and D at one adult tertiary hospital. The first purpose was to determine the impact of implementing this staffing method (NHPPD) on nursing-sensitive outcomes (NSOs). The second was to determine the relationship between skill mix and NSOs following implementation of NHPPD. The research design was an interrupted time series and used retrospective analysis of administrative data. Patient and staffing data using the NHPPD method over a four year period were analysed. The 14 NSOs were central nervous system (CNS) complications, wound infections, pulmonary failure, urinary tract infection, pressure ulcer, pneumonia, deep vein thrombosis, ulcer, gastritis and upper gastrointestinal bleed, sepsis, physiologic/metabolic derangement, shock/cardiac arrest, mortality, failure to rescue and length of stay.

The study found significant decreases in the rates of nine NSOs when examining hospital-level data following implementation of NHPPD (including mortality, sepsis and pneumonia). At the ward level, significant decreases in the rates of five NSOs (including mortality, shock/cardiac arrest and UTIs) occurred. Significant decreases in rates of eight NSOs (including failure to rescue, mortality and pneumonia) occurred with each 1% increase in RN hours across the three hospitals. At ward category level, significant decreases in the rates of five NSOs occurred with every 1% increase in RN hours (including failure to rescue, DVT and pneumonia).

The findings of this study suggest a richer skill mix, even with relatively small changes (1%), continues to benefit patients by improving NSOs. This study also provides nurse leaders with evidence to support the continuation of the NHPPD staffing method. It also adds to evidence about the importance of nurse staffing to patient safety, evidence that

must influence policy. Moreover, this study is one of the first to empirically review a specific nurse staffing method, based on an individual assessment of each ward to determine staffing requirements, rather than a “one-size-fits-all” approach.